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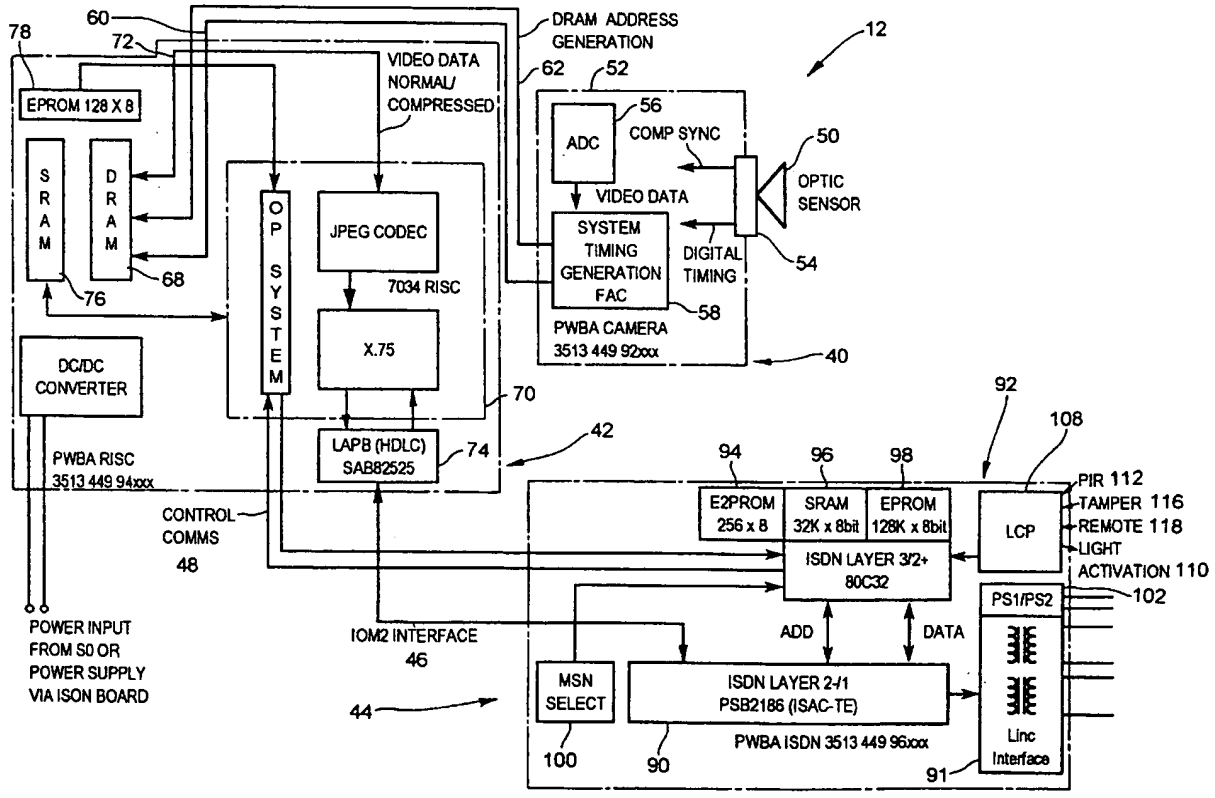
(54) **CAMERA DE RNIS ET SYSTEME DE SURVEILLANCE COMPRENANT CETTE CAMERA**

(54) **ISDN CAMERA AND SURVEILLANCE SYSTEM INCORPORATING SAME**



(57) An ISDN camera includes an imager to capture video images within a field of view and generate video data. An image processor is in communication with the imager and conditions the video data for transmission over the ISDN network. An ISDN interface communicates with the image processor and transmits the video data to a monitoring station over the ISDN network when a network connection between the ISDN camera and the monitoring station is established.

ABSTRACT

An ISDN camera includes an imager to capture video images within a field of view and generate video data. An image processor is in communication with the imager and conditions the video data for transmission over the ISDN network. An ISDN interface communicates with the image processor and transmits the video data to a monitoring station over the ISDN network when a network connection between the ISDN camera and the monitoring station is established.

ISDN CAMERA AND SURVEILLANCE SYSTEM INCORPORATING SAME

Field Of The Invention

The present invention relates to surveillance cameras and in particular to an Integrated Services Digital Network (ISDN) camera and a surveillance system incorporating the same.

Background Of The Invention

In many environments, security is an issue due to threat of burglary and/or vandalism. In the past, closed circuit television (CCTV) systems have been used to monitor premises to protect staff and property. A CCTV system typically includes a plurality of CCTV cameras positioned throughout the facility to be monitored. The CCTV cameras in the facility are connected to a stand alone digital encoding/compression unit via coaxial cabling and provide real time, slow scan images of the areas within their fields of view. Unfortunately, CCTV systems are very expensive. Also, since coaxial cabling must be run to connect the CCTV cameras to the digital encoding/compression unit, installation can be difficult and time consuming. In addition, if the CCTV system is to be retrofitted into an existing facility, the coaxial cabling often cannot be concealed. The result is an unsightly installation.

It is therefore an object of the present invention to provide a novel surveillance camera and surveillance system incorporating the same which obviates or mitigates at least one of the above-described disadvantages.

Summary Of The Invention

According to one aspect of the present invention there is provided an ISDN camera comprising:

an imager to capture video images within a field of view and generate video data;

an image processor in communication with said imager to condition said video data for transmission over an ISDN network; and

an ISDN interface in communication with said image processor, said ISDN interface transmitting video data received from said image processor to a monitoring station

over said ISDN network upon establishment of a network connection between said ISDN camera and said monitoring station.

Preferably, the ISDN interface is responsive to input received from an external input device to initiate an ISDN call to a monitoring station to establish the network connection. In a preferred embodiment, the ISDN interface includes an ISDN controller and memory storing telephone numbers associated with at least two monitoring stations. The ISDN controller accesses one of the telephone numbers in response to input from the external input device and uses that telephone number to initiate the ISDN call.

Preferably, the imager includes a camera module generating a continuous composite sync video signal of the field of view and an analog to digital converter to convert the continuous video signal into digital video data representing a succession of digital images. The image processor executes a compression algorithm to compress the digital video data and assembles the compressed video data into packets thereby to condition the video data for transmission over the ISDN network. In a preferred embodiment, the compression algorithm is a JPEG compression algorithm to compress the digital video data into a JFIF file format and the video data is assembled into X.75 packets.

According to another aspect of the present invention there is provided a surveillance system comprising:

a plurality of ISDN cameras positioned at selected locations within at least one facility to capture images within their fields of view, said ISDN cameras being connectable to an ISDN network; and

at least one monitoring station connectable to said ISDN network and executing an ISDN camera control application, wherein said ISDN cameras transmit video data to said monitoring station for display when a network connection over said ISDN network is established between said monitoring station and said ISDN cameras.

Preferably, the monitoring station displays images received from a plurality of ISDN cameras simultaneously. It is also preferred that the monitoring station further displays telephone numbers of contacts to be notified in the case of security incidents.

The ISDN camera in accordance with the present invention provides advantages in that since the ISDN camera plugs into a telephone socket and draws power

from power source 1 (ie. the PSTN), the ISDN camera is highly portable and can easily be repositioned within the facility when required. Also, since the ISDN camera plugs into a telephone socket and communicates with a monitoring station over an ISDN network, no coaxial cabling is required

The ISDN camera in accordance with the present invention also provides advantages in that it can be programmed to automatically switch on when triggered by the presence of an intruder in response to signals from an external output device such as a PIR detector. Once on, the ISDN camera establishes a network connection with a monitoring station and transmits images to the monitoring station without intruders becoming aware that they have been detected. Security incidents which result in the ISDN camera turning on can therefore be accessed visually before authorities are notified in order to reduce false alarms. The ISDN camera can also be switched on by establishing a call over the ISDN network either from the monitoring station or from a telephone.

Brief Description Of The Drawings

An embodiment of the present invention will now be described more fully with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a surveillance system in accordance with the present invention including a plurality of ISDN cameras;

Figure 2 is a schematic block diagram of an ISDN camera forming part of the surveillance system of Figure 1;

Figure 3 is a schematic block diagram of a camera module interface forming part of the ISDN camera of Figure 2;

Figure 4 is a schematic block diagram of a RISC, HDLC controller and a power control unit forming part of the ISDN camera of Figure 2;

Figure 5 is a schematic block diagram of an ISDN interface forming part of the ISDN camera of Figure 2;

Figure 6 is an image received from an ISDN camera displayed by a personal computer at a monitoring station forming part of the surveillance system of Figure 1; and

Figure 7 is a schematic diagram of a school surveillance system in accordance with the present invention including a plurality of ISDN cameras.

Detailed Description Of The Preferred Embodiment

Referring now to Figure 1, a surveillance system in accordance with the present invention is shown and is generally indicated to by reference numeral 10. The surveillance system 10 includes a plurality of Integrated Services Digital Network (ISDN) cameras 12 installed at selected positions throughout a facility 14 to be monitored. The facility 14 may be any type of facility such as for example, a school, a business, residences etc. The ISDN cameras 12 are plugged into telephone sockets installed throughout the facility and are connected to a switch 15 operable to access an ISDN network 16. As is well know, ISDN network 16 uses public switched telephone network (PSTN) switches and wiring that has been upgraded so that a basic network connection or "call" is carried out over a 64 kilobit per second (kb/s), all digital, end-to-end channel. A monitoring station 18 including a personal computer 20 installed with an ISDN card is also located at the facility 14 and is connected to the switch 15. The personal computer 20 runs an ISDN camera control application to allow the ISDN cameras 12 to be turned on remotely and to allow images received from the ISDN cameras 12 to be displayed.

A remote monitoring station 22 including a personal computer 24 installed with an ISDN card is also plugged into a telephone socket to permit access to ISDN network 16. Similar to personal computer 20, personal computer 24 runs an ISDN camera control application to allow the ISDN cameras 12 to be turned on remotely and to allow images received from the ISDN cameras 12 to be displayed. Telephones 26 are plugged into telephone sockets at various locations to permit access to the ISDN network 16. The telephones 26 can be used to call one or more of the ISDN cameras 12 to initiate their operation.

Turning now to Figure 2, one of the ISDN cameras 12 is better illustrated. As can be seen, ISDN camera 12 includes an imager 40, an image processor 42 connected to the imager 40 and an ISDN interface 44 connected to the image processor 42 via an IOM2 interface 46 and a control bus 48.

The imager 40 includes a CMOS camera module 50 such as that manufactured under model No. VVL5430 by Vision of the United Kingdom. The camera module 50 generates a continuous composite sync video signal of the area within its field of view together with associated digital timing signals. The output of the camera module 50 is conveyed to a camera interface 52, best seen in Figure 3. Camera interface 52 includes an optical interface 54 receiving the video signal output of the camera module 50 and an analog to digital converter (ADC) 56 connected to the optical interface 54 to convert the continuous composite sync video signal from analog to digital form. The digital timing signals output by the camera module 50 and the digital video data output by the ADC 56 are conveyed to a functional array calculator (FAC) 58. The FAC 58 in turn outputs the digital video data on a video data bus 60 and uses the digital timing signals to generate output supplied to a DRAM address bus 62.

The image processor 42 includes dynamic random access memory (DRAM) 68 connected to the video data and DRAM address busses 60 and 62 respectively. A reduced instruction set computer (RISC) 70 is connected to the DRAM 68 by a video data bus 72 and provides output to the ISDN interface 44 via a high-level data link control (HDLC) controller 74 over the IOM2 interface 46. Static random access memory (SRAM) 76 and electrically erasable programmable read only memory (E^2PROM) 78 are also included in the image processor 42. The SRAM 76 provides memory access to the RISC 70 when the DRAM 68 is loading digital video data from the imager 40 and also stores trace buffer data for system control and performance analysis. The E^2PROM 78 holds configuration data for the camera module 50 including overriding exposure controls. A power control unit (PCU) 80 in the form of a direct current to direct current (DC/DC) converter 80 supplies the necessary power to the imager 40 and image processor 42 and either draws power from power source 1 (ie. the PSTN) via a line interface 91 in the ISDN interface 44 or from a separate power supply.

The RISC 70 includes a RISC processor 82 and RISC memory 84 storing operating system (real time kernel) software for the RISC processor (see Figure 4). The RISC memory 84 is connected to the video data bus 72, and to the RISC processor 82 through address, data and control busses collectively identified by reference numeral 86. The RISC memory 84 stores digital video data received from the DRAM 68, a JPEG compression

algorithm, debug software as well as software for X.75 data transmission. The RISC processor 82 executes the JPEG compression algorithm to compress digital video data stored in the RISC memory 84. The RISC processor 82 also packetizes compressed digital video data for transmission over an ISDN B channel in X.75 format. The RISC processor 82 and RISC memory 84 are connected to the HDLC controller 74 via the address, data and control busses 86. The HDLC controller 74 transports the packetized compressed digital video data to the ISDN interface 44 over the IOM2 interface 46 in LAP-B format.

The ISDN interface 44 includes a basic rate interface (BRI) 90 such as that manufactured by Seimens under model No. PSB2186 connected to the line interface 91. The BRI 90 is also connected to the IOM2 interface 46 and receives packets from the HDLC controller 74 in LAP-B format within a single B-channel. An ISDN controller 92 including E^2PROM 94, SRAM 96 and EPROM 98 is connected to the BRI 90 as well as to the RISC processor 82 via the control bus 48. The ISDN controller 92 runs an ISDN D-channel communications protocol and handles the set up of ISDN calls. The ISDN controller 92 also controls the BRI 90 to select the B-channel utilized during ISDN calls. The ISDN controller 92 also stores the telephone numbers assigned to the monitoring stations 18 and 22 respectively and can be programmed to select different telephone numbers at different times to establish ISDN calls to appropriate monitoring stations. For example, during typical business hours, the ISDN controller 92 can be programmed to call the monitoring station 18 at the facility 14. Outside of business hours, the ISDN controller 92 can be programmed to call the remote monitoring station 22.

The ISDN controller 92 also includes a plurality of local control ports (LCP) 108. The local control ports 108 include a light control output port 110, a passive infrared (PIR) detector port 112, a PIR auxiliary power port 114, a tamper signal input port 116 and a remote activation port 118. A passive infra-red (PIR) detector (not shown) is connected to the PIR detector port 112 and receives a 12V power feed from the PIR auxiliary port 114. A rotary select switch 100 is connected to the ISDN controller 92 and allows the ISDN camera 12 to be assigned a call number so that multiple ISDN cameras 12 connected to the same port of switch 15 can be identified. The line interface 91 includes a power supply 102 having a

pair of settings, namely the power source 1 setting and a power source 2 setting. The power supply 102 supplies power to the PCU converter 78 and to the BRI 90.

The operation of the ISDN cameras and surveillance system will now be described.

Typically, the ISDN cameras 12 remain dormant but become active in response to either input from the PIR detectors or calls from one of the monitoring stations 18 or 22 or telephones 26.

When the PIR detector connected to an ISDN camera 12 detects the presence of an intruder, the PIR detector signals the ISDN controller 92 via the port 112. When the ISDN controller is signaled by the PIR detector, the ISDN controller 92, according to its programming, selects the number of the monitoring station to be called and sets up a D channel ISDN call to that monitoring station over the ISDN network 16. When the ISDN call is answered by the monitoring station, a network connection of bearer capability 64kbs unrestricted is established. The ISDN controller 92 also initiates a timer which is reset as long as input is received from the PIR detector.

The ISDN controller 92 also sets up the B channel of the ISDN call and signals the image processor 42 which in turn activates the imager 40. When the imager 40 is activated, the camera module 50 begins capturing video images resulting in the generation of a continuous, analog composite sync video signal and associated digital timing signals. The continuous video signal is applied to the ADC 62 where it is sampled at a nominal rate of 1.25Hz and digitized thereby to generate a succession of digitized images. The digitized images and the digital timing signals are conveyed to the FAC 58. The FAC 58 in turn outputs the digital video data to the DRAM 68 over the video data bus 60 and uses the digital timing signals to generate the output supplied to the DRAM address bus 62. As the digital video data is stored in the DRAM 68, the digital video data is read into the RISC memory 84 by the RISC 70. The RISC processor 82 in turn compresses the digital video data using the JPEG compression algorithm 82 into a standard JFIF file format. The JFIF files are then stored back in the DRAM 68. Thereafter, the RISC processor 82 retrieves compressed JFIF files from the DRAM 68 and assembles the files into X.75 packets. The assembled X.75

packets are conveyed to the HDLC controller 74 and then transported to the BRI 90 over a B-channel of the IOM2 interface 46 in LAP-B format.

As the BRI 90 receives the X.75 packets in LAP-B format, the BRI transmits the packets over the established network connection to the personal computer at the monitoring station. The personal computer which receives the re-assembled packets from the ISDN network 16, stores each image on its hard disk as it is received and displays each image in a window 120 together with useful contact numbers 122 such as for example, the number of the local police (see Figure 6). An audible alarm is also sounded to notify an operator that at least one ISDN camera is operational and is transmitting images. If multiple ISDN cameras are operating, the images from up to four ISDN cameras can be presented simultaneously on the display The operator monitoring the personal computer is then able to take action quickly and in an informed manner as the situation unfolds within their view. The images stored on the hard drive can be transferred onto video cassette to free up memory in the personal computer and to archive surveillance footage.

The ISDN camera 12 continues to transmit images to the monitoring station while the PIR detector detects the presence of an intruder. When the PIR detector ceases to provide input to the ISDN camera, images are transmitted to the monitoring station until the timer expires or until a cancel network connection command is generated by the ISDN camera control application in response to operator input. When the timer expires, the ISDN controller 92 terminates the network connection.

When the ISDN camera 12 receives an ISDN call initiated through the personal computer at one of the monitoring stations, the ISDN camera operates in a similar manner except the ISDN controller 92 does not initiate the timer. Images are therefore transmitted to the monitoring station until a cancel network connection command is generated by the ISDN camera control application in response to operator input.

When the ISDN camera receives a call from a telephone 26 to initiate operation, the ISDN controller recognizes the call is being incompatible bearer voice. The ISDN controller 92 in turn clears the call and then establishes an ISDN call to the appropriate monitoring station in the manner described above. Images are transmitted to the monitoring

station until the ISDN camera control application generates a cancel network connection command in response to operator input.

As will be appreciated, the ISDN cameras 12 in conjunction with the monitoring station provide a solution equivalent in real time to a "slow scan" CCTV system at significantly reduced expense and without the need to run unslightly cabling. Normally, assuming a fast response from the ISDN network, the ISDN cameras 12 can become operational in approximately 1 second.

Although the ISDN camera is described as being connected to a switch operable to access the ISDN network 16, those of skill in the art will appreciate that the ISDN camera may be connected directly to the ISDN network. In this case, PCU 80 needs to be connected to a separate power source. Also, if desired, the BRI 90 can use both B-channels to transmit packets to increase the frame rate and/or resolution of transmitted images.

Turning to Figure 7, a surveillance system for schools incorporating the ISDN cameras 12 is shown and is generally indicated to by reference numeral 200. In the example shown, two schools 200 and 202 are provided with ISDN cameras 212 and associated switches 215 connected to the ISDN 216. A remote monitoring system 222 including a personal computer 224 with an ISDN card is connected to the ISDN network 216 to establish network connections with the ISDN cameras 212 in the schools.

The ISDN cameras 212 in the schools are controlled by teachers using telephones so that the ISDN cameras are usually not active during teaching sessions. In this manner, invasion of privacy of the teaching environment by an operator at the remote monitoring station 222 is not a concern. The ISDN cameras 212 are however, programmed to call the remote monitoring station 222 when triggered by a teacher making a call to the ISDN cameras 212 or by the PIR detectors.

Although a preferred embodiment of the present invention has been described, those of skill in the art will appreciate that variations and modifications may be made without departing from the spirit and scope thereof as defined by the appended claims.

We Claim:

1. An ISDN camera comprising:

an imager to capture video images within a field of view and generate video data;

an image processor in communication with said imager to condition said video data for transmission over an ISDN network; and

an ISDN interface in communication with said image processor, said ISDN interface transmitting video data received from said image processor to a monitoring station over said ISDN network upon establishment of a network connection between said ISDN camera and said monitoring station.

2. An ISDN camera as defined in claim 1 wherein said ISDN interface is responsive to input received from an external input device to initiate an ISDN call to a monitoring station to establish said network connection.

3. An ISDN camera as defined in claim 2 wherein said ISDN interface includes an ISDN controller and memory storing telephone numbers associated with at least two monitoring stations, said ISDN controller accessing one of said telephone numbers in response to input from said external input device and using said one telephone number to initiate said ISDN call.

4. An ISDN camera as defined in claim 3 wherein said ISDN controller is programmed to access telephone numbers associated with said monitoring stations at selected times.

5. An ISDN camera as defined in claim 2 wherein said ISDN interface includes a power supply drawing power from a public switched telephone network and supplying power to said ISDN interface, said image processor and said imager.

6. An ISDN camera as defined in claim 2 wherein said imager includes a camera module generating a continuous composite sync video signal of said field of view and an analog to digital converter to convert said continuous video signal into digital video data representing a succession of digital images.

7. An ISDN camera as defined in claim 6 wherein said image processor executes a compression algorithm to compress said digital video data and assembles said compressed video data into packets thereby to condition said video data for transmission over said ISDN network.

8. An ISDN camera as defined in claim 7 wherein said compression algorithm is a JPEG compression algorithm to compress said digital video data into a JFIF file format and wherein said video data is assembled into X.75 packets.

9. An ISDN camera as defined in claim 8 wherein said packets are conveyed from said image processor over a B-channel to a basic rate interface of said ISDN interface in an LAP-B format.

10. An ISDN camera as defined in claim 2 wherein said ISDN interface is responsive to an incoming call from a monitoring station to initiate capturing of images and transmission of said video data to said monitoring station.

11. An ISDN camera as defined in claim 2 wherein said external input device is a PIR detector.

12. A surveillance system comprising:

a plurality of ISDN cameras positioned at selected locations within at least one facility to capture images within their fields of view, said ISDN cameras being connectable to an ISDN network; and

at least one monitoring station connectable to said ISDN network and executing an ISDN camera control application, wherein said ISDN cameras transmit video data to said monitoring station for display when a network connection over said ISDN network is established between said monitoring station and said ISDN cameras.

13. A surveillance system as defined in claim 12 wherein said monitoring station displays images received from a plurality of ISDN cameras simultaneously.

14. A surveillance system as defined in claim 13 wherein said monitoring station further displays telephone numbers of contacts to be notified in the case of security incidents.

15. A surveillance system as defined in claim 12 wherein said at least one monitoring station is operable to initiate an ISDN call to said ISDN cameras to establish said network connection.

16. A surveillance system as defined in claim 15 wherein said ISDN cameras transmit said video data to said at least one monitoring station as soon as said network connection has been established.

17. A surveillance system as defined in claim 16 wherein each ISDN camera includes an imager to capture images within a field of view and generate video data; an image processor in communication with said imager to condition said video data for transmission over said ISDN network; and an ISDN interface in communication with said processor, said ISDN interface transmitting video data received from said image processor to said at least one monitoring station over said ISDN.

18. A surveillance system as defined in claim 17 wherein said ISDN interface is responsive to input received from an external input device to initiate a call to said at least one monitoring station to establish said network connection.

19. A surveillance system as defined in claim 18 wherein said external input device is a PIR detector.

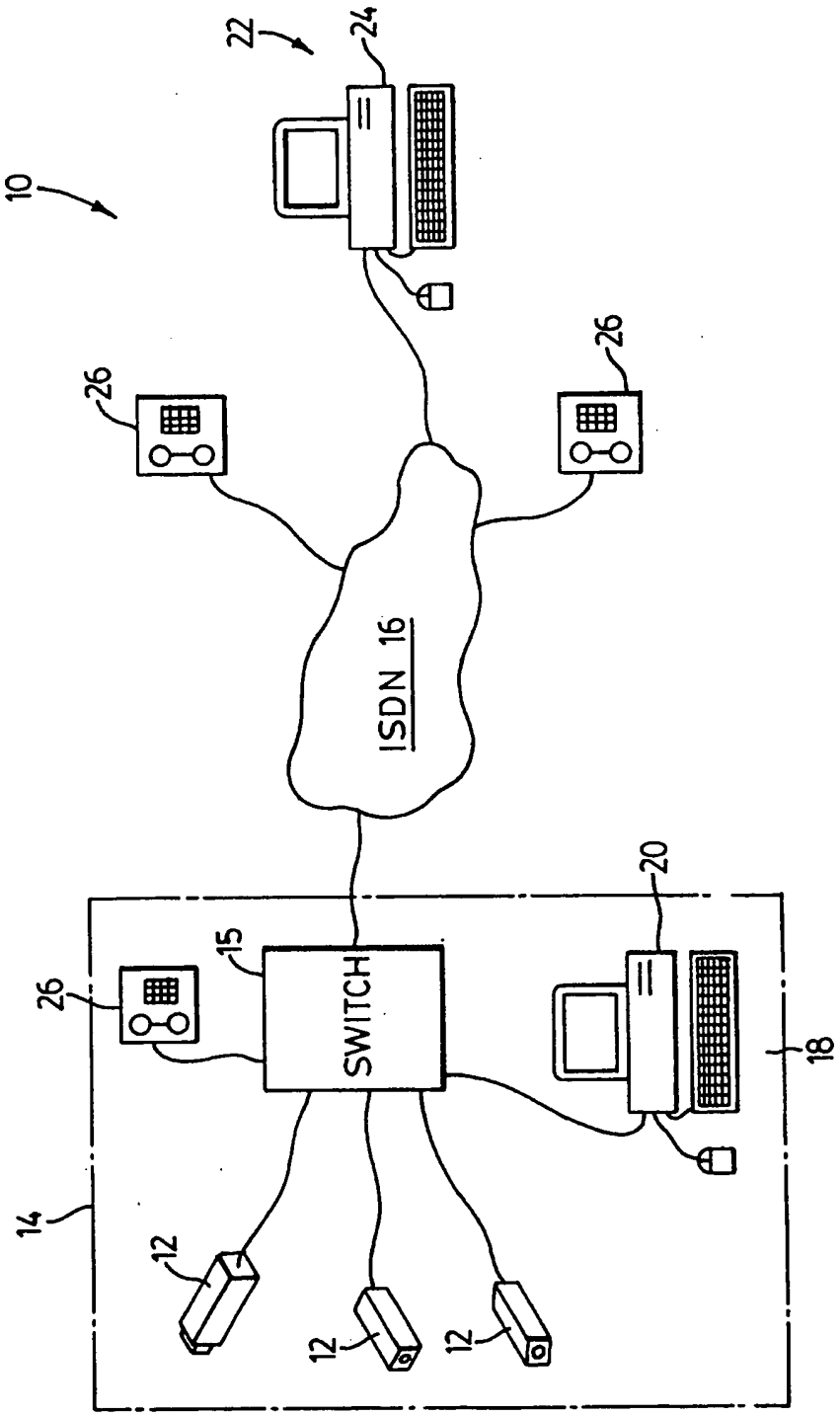
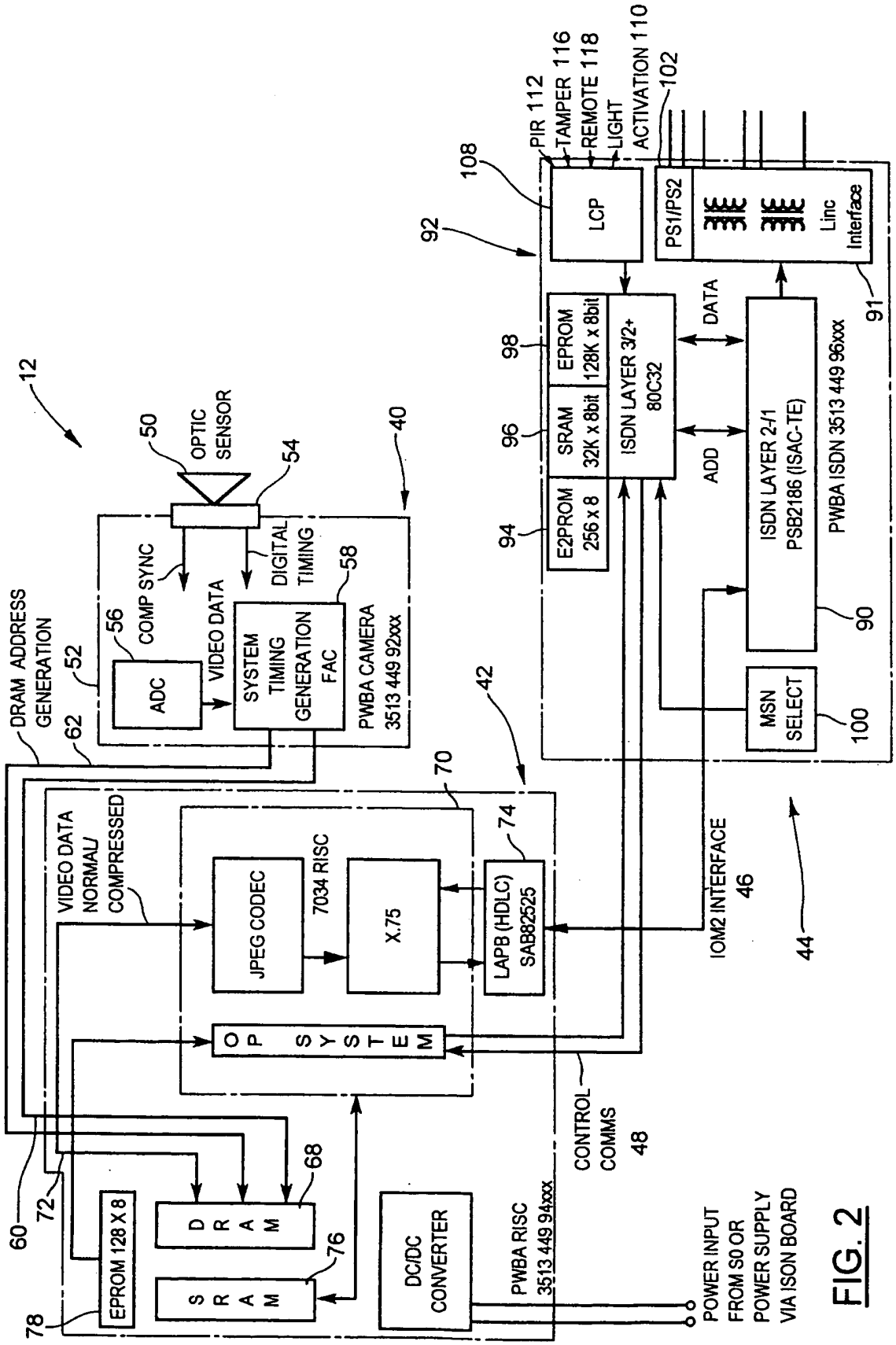


FIG. 1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PWBA CAMERA 3513 449 92xxx
52
DRAM ADDRESS GENERATION
62
42
70
VIDEO DATA NORMAL/ COMPRESSED
JPEG CODEC
7034 RISC
X.75
74
LAPB (HDLC) SAB82525
O P S Y S T E M
IOM2 INTERFACE 46
44
CONTROL COMMS 48
60
72
68
D R A M
S R A M
76
EPROM 128 X 8
78
DC/DC CONVERTER
PWBA RISC 3513 449 94xxx
POWER INPUT FROM S0 OR POWER SUPPLY VIA ISON BOARD
92
108
PIR 112
TAMPER 116
REMOTE 118
LIGHT
ACTIVATION 110
102
LCP
PS1/PS2
Linc Interface
91
98
EPROM 128K x 8bit
96
SRAM 32K x 8bit
ISDN LAYER 3/2+ 80C32
DATA
94
E2PROM 256 x 8
ADD
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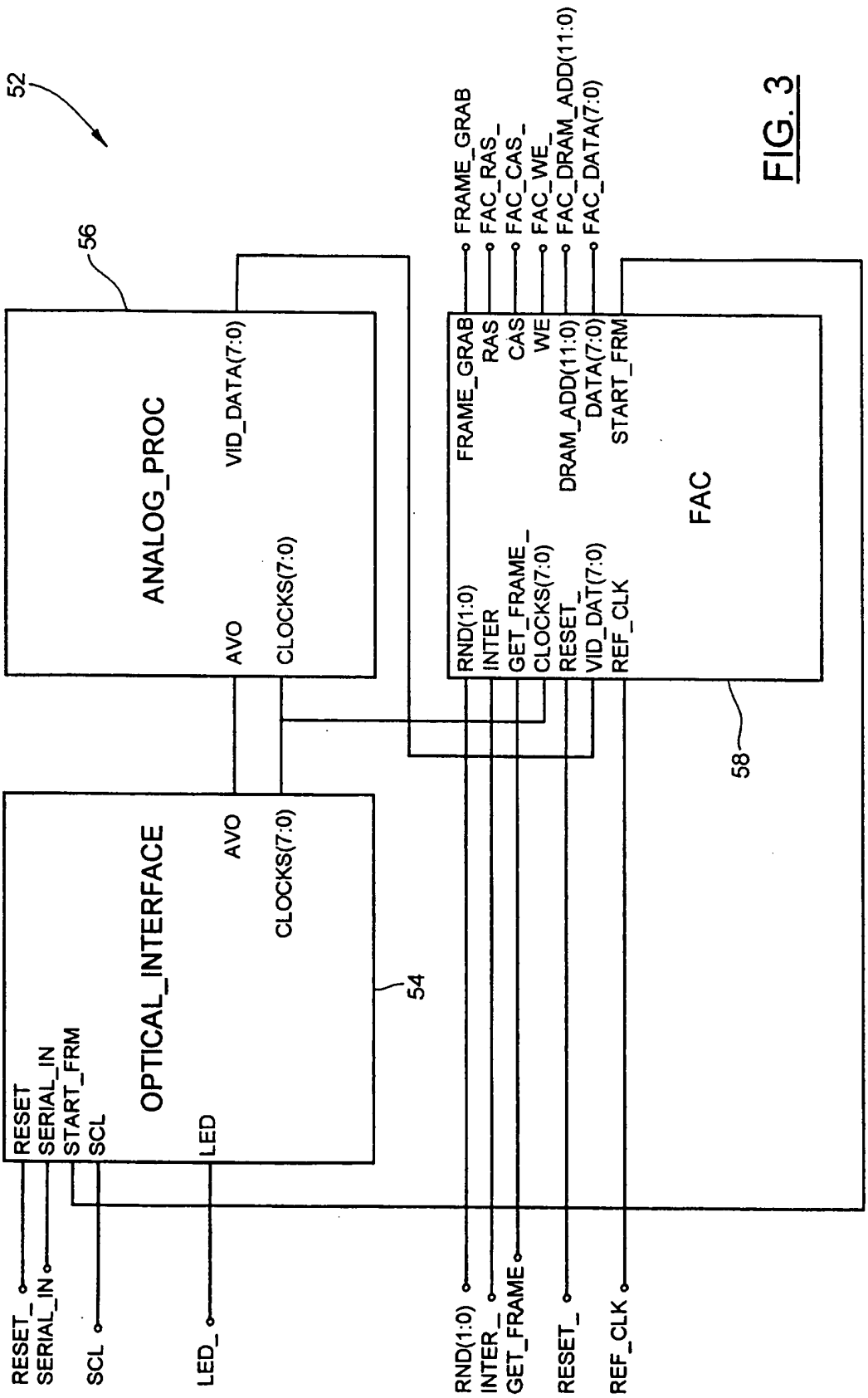
PWBA ISDN 3513 449 96xxx
90
MSN SELECT
100

FIG. 2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WE
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RND(1:0)
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GET_FRAME_
CLOCKS(7:0)
RESET_
VID_DAT(7:0)
REF_CLK
58
OPTICAL_INTERFACE
AVO
CLOCKS(7:0)
54
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SERIAL_IN
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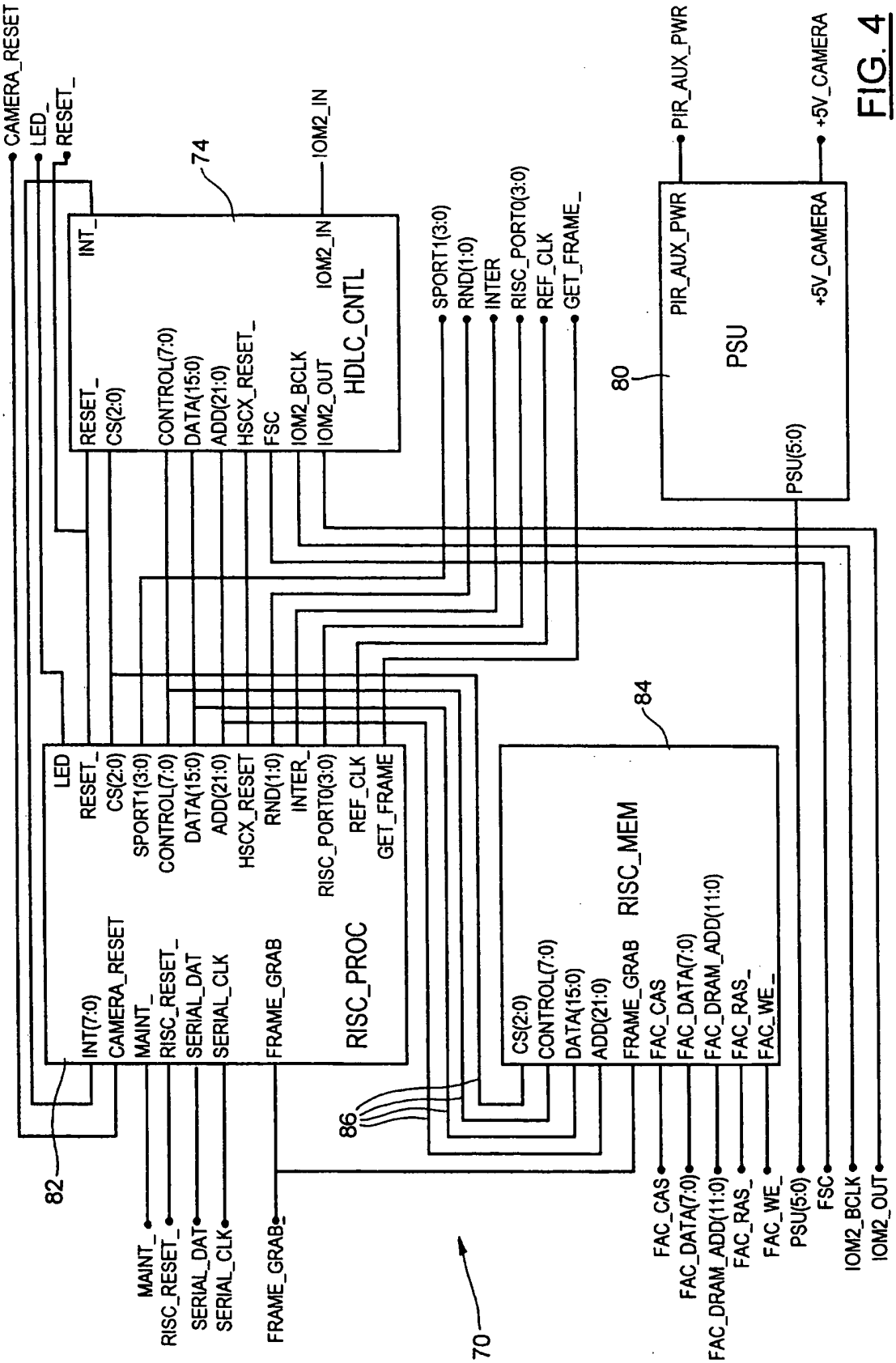
FIG. 3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HSCX_RESET_
FSC
IOM2_BCLK
IOM2_OUT
IOM2_IN
IOM2_IN
SPORT1(3:0)
RND(1:0)
INTER
RISC_PORT0(3:0)
REF_CLK
GET_FRAME_
80
PSU
PIR_AUX_PWR
+5V_CAMERA
PSU(5:0)
PIR_AUX_PWR
+5V_CAMERA
RISC_PROC
LED
RESET_
CS(2:0)
SPORT1(3:0)
CONTROL(7:0)
DATA(15:0)
ADD(21:0)
HSCX_RESET
RND(1:0)
INTER_
RISC_PORT0(3:0)
REF_CLK
GET_FRAME
INT(7:0)
CAMERA_RESET
MAINT_
RISC_RESET_
SERIAL_DAT
SERIAL_CLK
FRAME_GRAB
82
84
RISC_MEM
CS(2:0)
CONTROL(7:0)
DATA(15:0)
ADD(21:0)
FRAME_GRAB
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FAC_DATA(7:0)
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86
70
MAINT_
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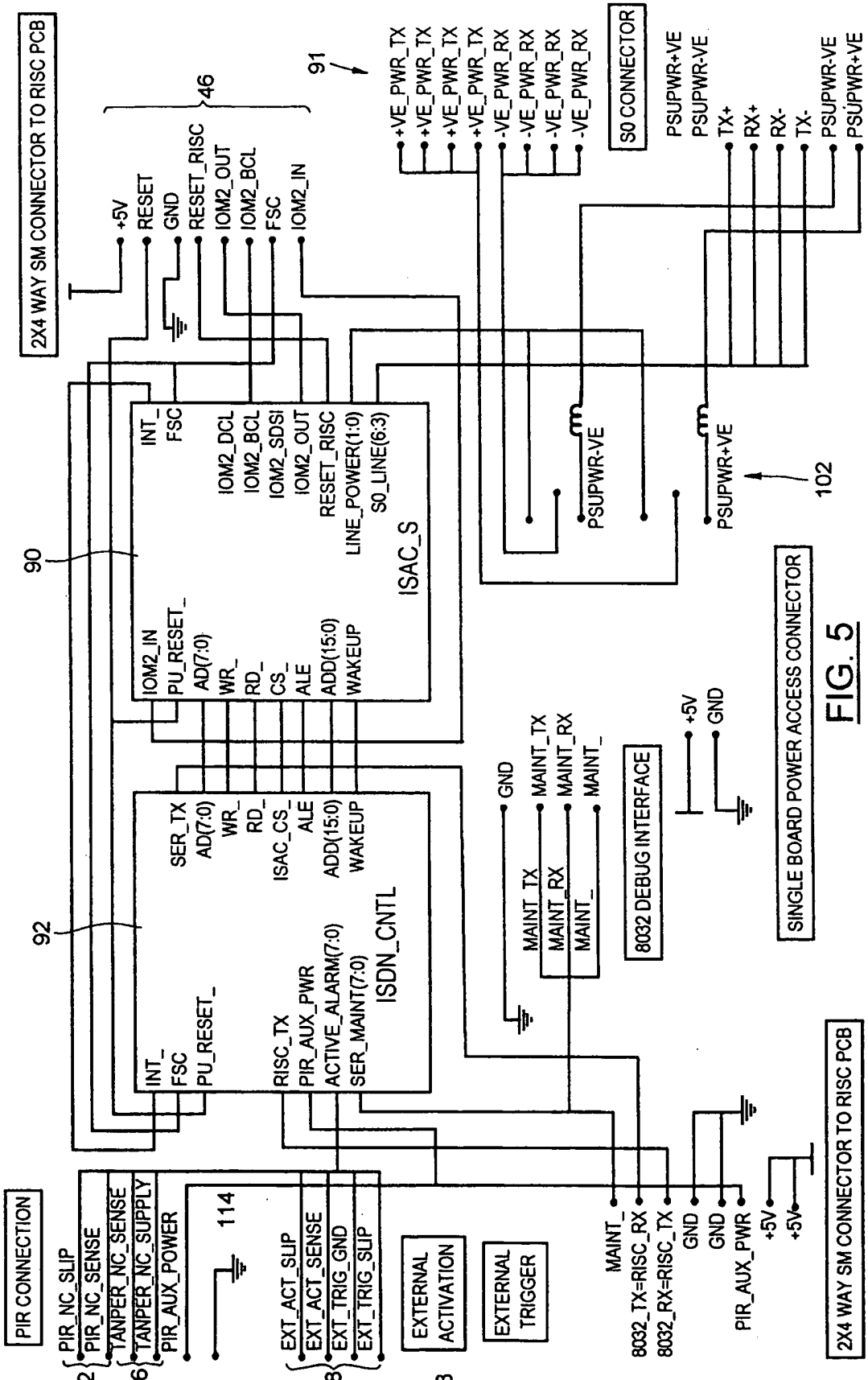
IOM2_OUT

FIG. 4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+5V
RESET
GND
RESET_RISC
IOM2_OUT
IOM2_BCL
FSC
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+VE_PWR_TX
+VE_PWR_TX
+VE_PWR_TX
-VE_PWR_RX
-VE_PWR_RX
-VE_PWR_RX
-VE_PWR_RX
S0 CONNECTOR
PSUPWR+VE
PSUPWR-VE
TX+
RX+
RX-
TX-
PSUPWR-VE
PSUPWR+VE
90
INT_
FSC
IOM2_DCL
IOM2_BCL
IOM2_SDSI
IOM2_OUT
RESET_RISC
LINE_POWER(1:0)
S0_LINE(6:3)
ISAC_S
IOM2_IN
PU_RESET_
AD(7:0)
WR_
RD_
CS_
ALE
ADD(15:0)
WAKEUP
PSUPWR-VE
PSUPWR+VE
102
92
SER_TX
AD(7:0)
WR_
RD_
ISAC_CS_
ALE
ADD(15:0)
WAKEUP
ISDN_CNTL
INT_
FSC
PU_RESET_
RISC_TX
PIR_AUX_PWR
ACTIVE_ALARM(7:0)
SER_MAINT(7:0)
GND
MAINT_TX
MAINT_RX
MAINT_
MAINT_TX
MAINT_RX
MAINT_
8032 DEBUG INTERFACE
+5V
GND
SINGLE BOARD POWER ACCESS CONNECTOR
PIR CONNECTION
PIR_NC_SLIP
PIR_NC_SENSE
TANPER_NC_SENSE
TANPER_NC_SUPPLY
PIR_AUX_POWER
112
116
114
EXT_ACT_SLIP
EXT_ACT_SENSE
EXT_TRIG_GND
EXT_TRIG_SLIP
118
EXTERNAL ACTIVATION
108
EXTERNAL TRIGGER
MAINT_
8032_TX=RISC_RX
8032_RX=RISC_TX
GND
GND
PIR_AUX_PWR
+5V
+5V
2X4 WAY SM CONNECTOR TO RISC PCB

FIG. 5

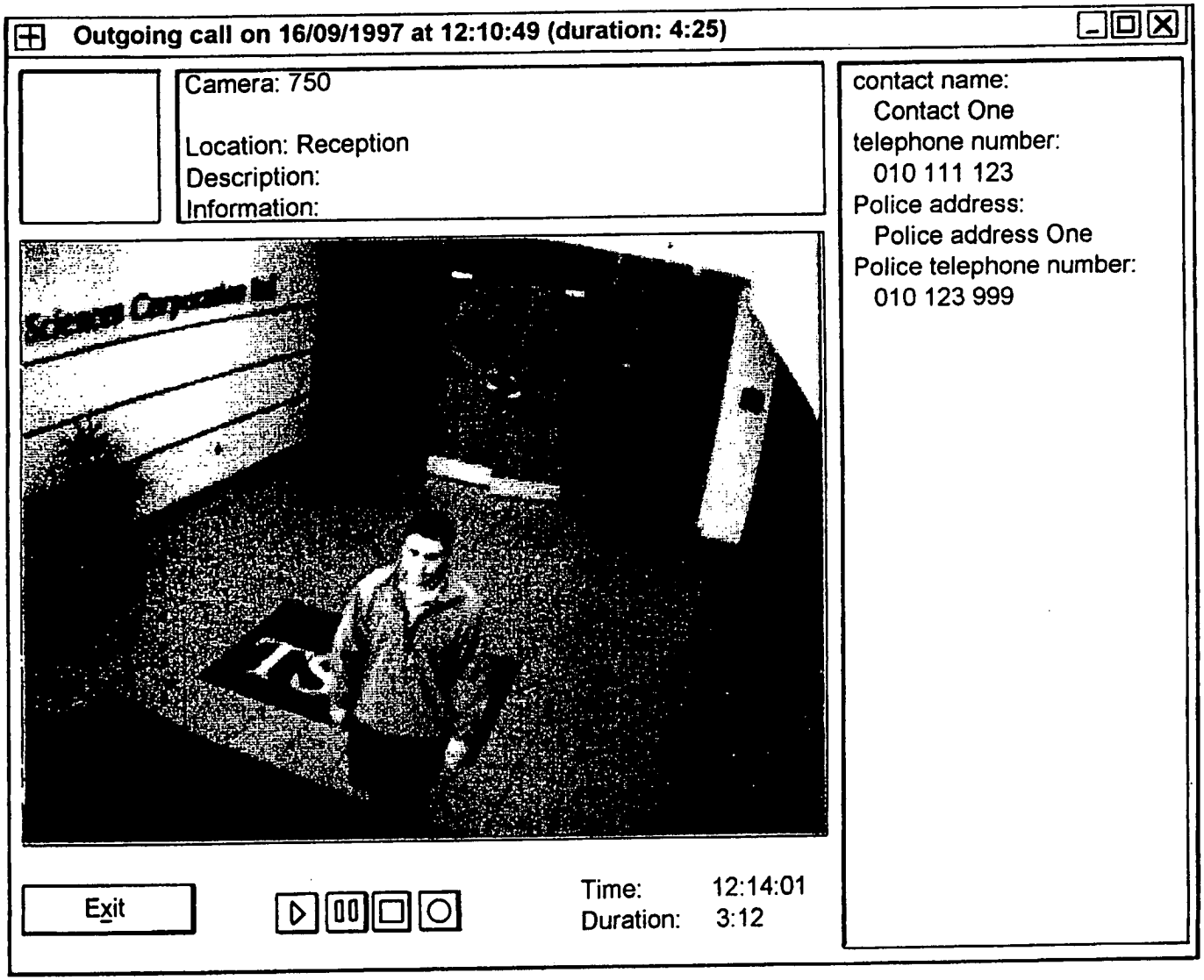

FIG. 6

CA 02246266 1998-11-19

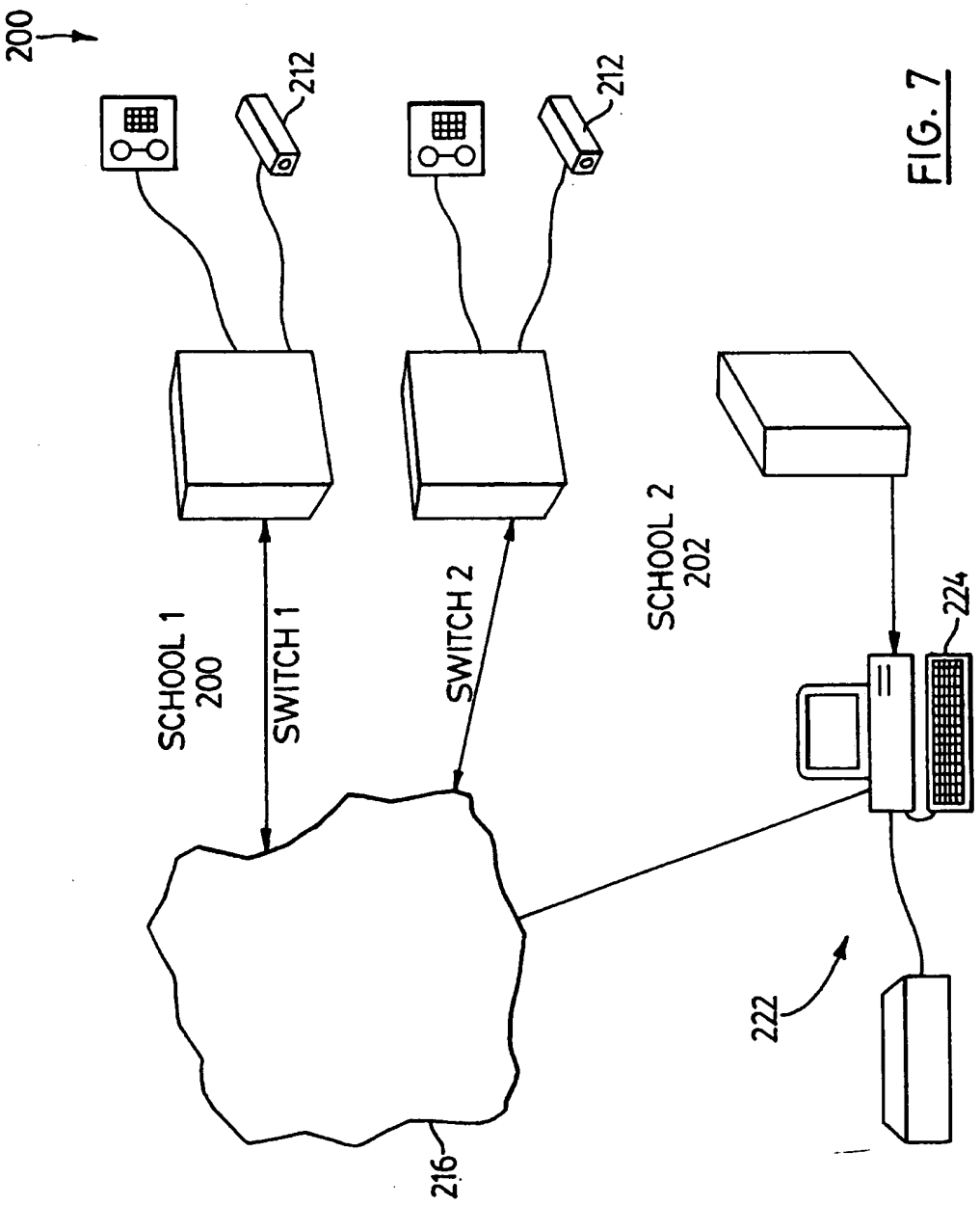
200
212
212
SCHOOL 1
200
SWITCH 1
SWITCH 2
SCHOOL 2
202
224
222
216

FIG. 7